Solubility Rules

In a chemical reaction (namely double replacement) there must be an understanding of the solubility rules. For a reaction to proceed there must be a driving force – a new molecular substance (NMS) such as water where all aqueous reactants form at least one insoluble product.

- All compounds of the ammonium ion (NH_4^+), and of Alkali metal (Group IA) cations, are soluble.
- All nitrates and acetates (ethanoates) are soluble.
- All chlorides, bromides and iodides are soluble **EXCEPT** those of silver, lead and mercury(I).
- All sulphates are soluble **EXCEPT** those of silver, lead, mercury(I), barium, strontium and calcium.
- All carbonates, sulfites and phosphates are insoluble **EXCEPT** those of ammonium and Alkali metal (Group IA) cations.
- All hydroxides are insoluble **EXCEPT** those of ammonium, barium and alkali metal (Group I) cations.
- All sulfides are insoluble **EXCEPT** those of ammonium, Alkali metal (Group I) cations and Alkali earth Group
- All oxides are insoluble **EXCEPT** those of calcium, barium and Alkali metal (Group I) cations; these soluble ones actually react with the water to form hydroxides (hydrolyse).

Negative Ions (Anions)	+	Positive Ions (Cations)	=	Solubility of compounds in water
any anion	+	alkali ions (Li^+,Na^+,K^+,Rb^+,Cs^+,Fr^+)	=	soluble
any anion	+	hydrogen ion [$H^+_{(aq)}$]	=	soluble
any anion	+	amonium ion (NH_4^+)	=	soluble
nitrate NO_3^-	+	any cation	=	soluble
acetate (CH_3COO^-)	+	any cation	=	soluble
Chloride (Cl^-), Bromide (Br^-), Iodide (I^-)	+	silver (Ag^+), lead (Pb^{2+}), mercury (Hg^{2+}), copper (Cu^+), thallium (Tl^+)	=	low solubility (insoluble)
	+	any other cation	=	soluble
Sulphate (SO_4^{2-})	+	calcium (Ca^{2+}), strontium (Sr^{2+}), barium (Ba^{2+}), silver (Ag^+), lead (Pb^{2+}), radium (Ra^{2+})	=	low solubility (insoluble)
	+	any other cation	=	soluble
Sulfide S^{2-}	+	alkali ions (Li^+,Na^+,K^+,Rb^+,Cs^+,Fr^+), alkali earth metals (Be^{2+},Mg^{2+},Ca^{2+},Sr^{2+},Ba^{2+},Ra^{2+}), and $H^+_{(aq)}$, NH_4^+	=	soluble
	+	any other cation	=	low solubility (insoluble)
Hydroxide OH^-	+	alkali ions (Li^+,Na^+,K^+,Rb^+,Cs^+,Fr^+), $H^+_{(aq)}$,NH_4^+,Sr^{2+},Ba^{2+},Ra^{2+},Tl^+	=	soluble
	+	any other cation	=	low solubility (insoluble)
Phosphate, PO_4^{3-}, Carbonate, CO_3^{2-}, sulphite, SO_3^{2-}	+	alkali ions (Li^+,Na^+,K^+,Rb^+,Cs^+,Fr^+), $H^+_{(aq)}$,NH_4^+	=	soluble
	+	any other cation	=	low solubility (insoluble)

**Adapted from Al Olsen (Towson High School) and an unknown google image